# MICROOHM/BOND METER

# MODEL R1L-BR1

Instruction Manual
PN# R1L-BR1-900-01
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REV. C

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NOTE: This User's Manual was as current as possible when this product was manufactured. However, products are constantly being updated and improved. To ensure you have the latest documentation, refer to www.tegam.com

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# SECTION 1

# INSTRUMENT DESCRIPTION

## 1.1 Introduction

The TEGAM Model R1L-BR1 bond meter is a purpose built, rechargeable battery powered portable instrument for ground bond measurements. The R1L-BR1 comes with push-pin probes and Kelvin alligator clips, all housed within a ruggedized case. It can accurately make measurements with a resolution of 1 μΩ. It has full scale ranges from 2 mΩ to 20 Ω. The resistance reading is displayed on a 3½ digit liquid crystal display on the front panel. An over-range condition is indicated as a "1" followed by three blank digits (the decimal point is also displayed in its normal position for the range selected).

## 1.2 Performance Characteristics

This is a range-selection instrument, with a rotary 5 range selector switch.

| Range | Full Scale (Ω) | Resolution (Ω) | Test Current Peak (A) |
|---|---|---|---|
| 1 | 1.999 m | 1 μ | 1.4 |
| 2 | 19.99 m | 10 μ | 140 m |
| 3 | 199.9 m | 100 μ | 14 m |
| 4 | 1.999 | 1 m | 1.4 m |
| 5 | 19.99 | 10 m | 140 μ |

Table 1: Specifications

**Accuracy:**
Accuracy on all ranges: ± (0.25% of reading + 1 count), when powered from the batteries only.

## 1.3 Description of Equipment

Physical: The circuitry is enclosed in a rugged case.

Dimensions: 14.1 in (358 mm) W x 10.6 in (269 mm) D x 6.1 in (155 mm) H. Weight with accessories is 4.45 kg (9.8 lb). Controls and connectors are of a size and spacing such that the instrument may be operated while wearing safety gloves.

Electrical: The R1L-BR1 is powered by an internal battery consisting of three rechargeable NiCad 'C' cells (2800 mAh - 3500 mAh) with a built-in charger. Input power for the charger is 90 VAC to 250 VAC at 50 Hz or 60 Hz. Charging power is supplied via a removable line cord; one end of which plugs into a line filter on the front of the R1L-BR1, and the other end being a standard three-pin grounded line plug.
Fuse: ¼ A 3AG Slow blow, TEGAM PN#FU-202

Input Protection: The R1L-BR1 will not be damaged by a signal of 1 Vp-p applied across any pair of input terminals.

Environmental: This unit will operate over a temperature range from 0 °C to 50 °C, 75% RH non-condensing, up to 3050 m altitude.

**Front Panel Controls and Displays** (See figure 1)

**RANGE Switch**. The rotary 5 range selector switch may be used to step through all five ranges.

**POWER Switch**. Used to turn the power on or off to the instrument.

**DISPLAY** is a 3 ½ digit, displaying readings from 1.999 to 199.9.

**Four binding posts** for connection of test leads are marked +I, +E, -E, and -I. Proper connections to the resistor under test are described in Section 3.2 below.

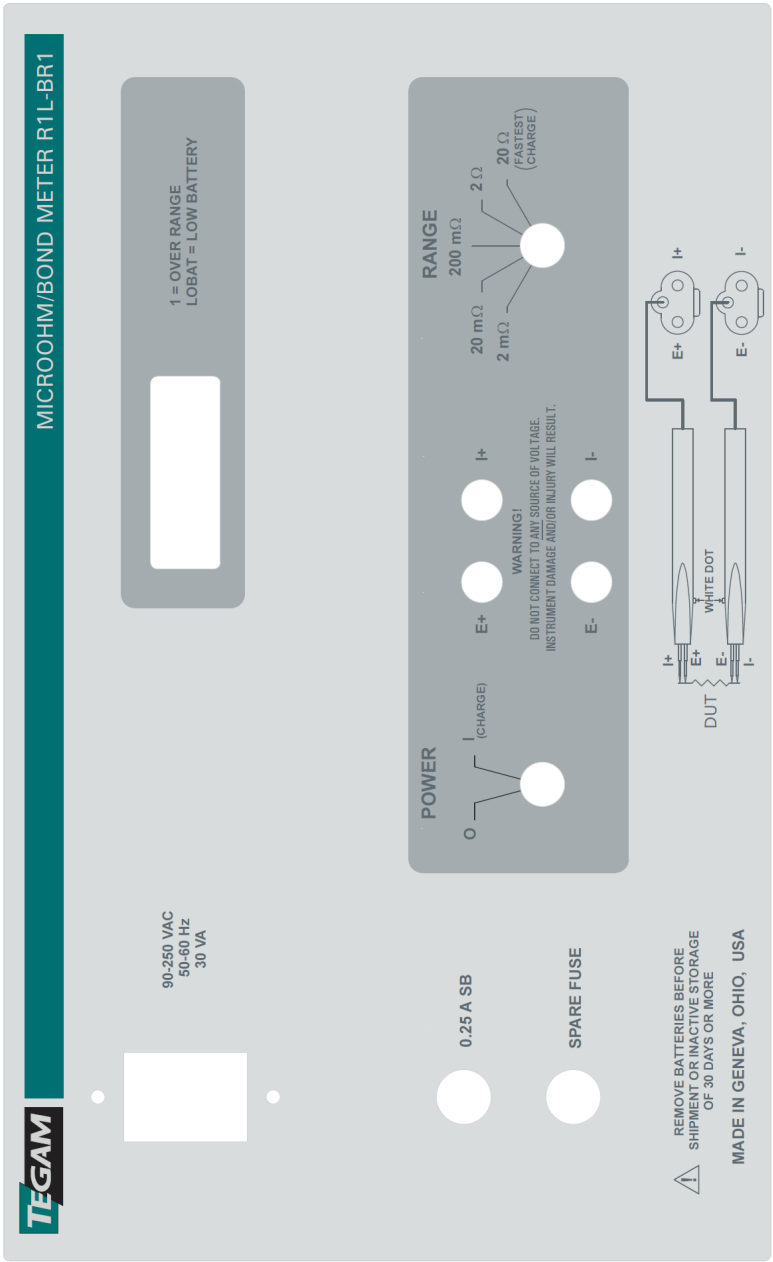


Figure 1: Front Panel Controls

## 1.4 List of Items Furnished

1 each Model R1L-BR1 with power cord
3 each rechargeable NiCad battery cells (P/N: BA-110)
1 each R1L-BR1 Instruction Manual (P/N: R1L-BR1-900-01)
2 each Kelvin Clip Cables, one end with a dual banana plug and the other end with a gold plated Kelvin clip (P/N: KTL-100)
2 each Kelvin Probes, one end with a dual banana plug and the other end with a Kelvin Probe with replaceable tips (8 each) (P/N: BCP-10)

## 1.5 Storage and Shipping Requirements

Standard precautions which apply to electronic test instruments should be followed. A hard mechanical shock, such as from dropping the R1L-BR1, could damage the liquid crystal display. Care should be taken to prevent damage to associated cables.
Remove the battery cells for inactive storage of 30 days or more.

Temperature: -40 °C to +71 °C.
Relative humidity: 0 to 100%, non-condensing.
Altitude: 4570 m
See Section 5.6 below for shipping requirements.

## 1.6 Safety Information and Precautions ⚠

### Grounding the Equipment

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock or other potential safety hazards, plug the power cord into a properly wired receptacle before using this instrument. The proper grounding of this instrument is essential for safety and optimizing instrument operation.

**Danger Arising from Loss of Ground**

If the connection to ground is lost or compromised while charging the batteries, a floating potential could develop in the instrument. Under these conditions all accessible parts, including insulating parts such as knobs and terminals could develop a hazardous voltage and put the user at risk.

**Use the Proper Fuse**

To avoid fire hazard, use only the correct fuse type as specified for the AC power supply in the "Description of Equipment" or "Maintenance" sections of this manual.

**Do Not Use in Explosive Environments**

The R1L-BR1 microohmmeter is not designed for operation in explosive environments.

# SECTION 2

# PREPARATION FOR USE AND INSTALLATION

## 2.1 Unpacking and Inspection

Upon receipt, the R1L-BR1 and accessories should be carefully unpacked and removed from the shipping container. Separate the units from the packing material and inspect both the instrument and the accessories for any external damage.

- If any dents, broken, or loose parts are seen, do not use the equipment, and notify TEGAM immediately.
- Check that all items are present. If any items are missing, notify TEGAM immediately.
- Note that the instrument is shipped with its battery removed. Unwrap the 3 cells which comprise the battery.

## 2.2 Preparation for Use

**Battery Installation**

Be sure the power line cord is disconnected. Check that the Power Switch is in the OFF position. Remove the ten screws around the R1L-BR1's top (control/display) panel. Carefully lift the unit out of its cabinet. Place the unit upside down on a surface which will not mar or damage the control/display panel.

**WARNING**

**DO NOT CONNECT THE AC LINE CORD PRIOR TO REMOVING THE UNIT FROM ITS CASE OR WHILE THE UNIT IS OUT OF ITS CASE, OR ELSE THE MAINS VOLTAGE WILL PRESENT A POSSIBLE SHOCK HAZARD.**

**CAUTION**

**BE SURE TO OBSERVE THE PROPER POLARITY WHEN INSERTING THE BATTERY CELLS OR DAMAGE MAY RESULT.**

Insert the battery cells, one at a time, in accordance with the polarity indications marked on both the battery cell and the battery holder. Insert the positive end of the battery cells first.
After installing the cells, reinstall the instrument in its case and secure the ten screws.

**Power Up**
Plug the power cord into the R1L-BR1 front panel receptacle, and plug the other end into a standard AC outlet. For battery operation (with charged battery cells), this step is omitted. Turn on the POWER rotary switch. Note that this switch turns on both line and battery power.

**Charging the Battery Cells**
Prior to battery operation, it is recommended the R1L-BR1 Microohm/Bond Meter be plugged into AC power for at least 14 hours to charge the battery cells. To charge the battery cells, the Power Switch must be turned ON, and the Range Switch should be set to 20 Ω. With the Range Switch set to lower ranges, the charge rate decreases and the batteries will be discharged, especially on the 2 mΩ range, even with no resistance connected to the instrument. (However, the discharge rate in this range will permit operation for at least 14 hours with no resistance connected.)

**WARNING**
**ALTHOUGH THE FRONT PANEL IS NORMALLY GROUNDED VIA THE GROUND PIN OF THE POWER CABLE, IF THIS CONNECTION IS FAULTY AND IF THE HIGH SIDE OF THE POWER CABLE IS SHORTED TO THE PANEL, THE PANEL COULD POSSIBLY HAVE MAINS VOLTAGE ON IT; SO DO NOT TOUCH THE PANEL WHEN AC POWER IS CONNECTED.**

# SECTION 3

# OPERATING INSTRUCTIONS

The R1L-BR1 is designed for field or bench-top operation. Use appropriate cables connecting their terminations to the four binding posts marked +I, +E, -E, and -I.

**WARNING**
**DO NOT TOUCH THE BINDING POSTS WHEN THEY ARE CONNECTED TO EXTERNAL CIRCUITS. LETHAL VOLTAGES MAY BE PRESENT AT THESE POSTS.**

## 3.1 Rotary Switch Functions

Operation of the Model R1L-BR1 is simple. There are only two switches.

The RANGE rotary switch manually scrolls through the five ranges.

Full scale on any range may be described as 2,000 counts (actually 1,999), since this is a 3½ digit meter. If the readings are exceeding 1,999 counts, step to the next higher range. If the readings are less than 2,000 counts, step down a range, so that it will read 1,999 counts, or less. The decimal point is located automatically for the correct reading.

If the selected range is too low for the value of the resistor under test, the display will show over-range.

The POWER rotary switch turns on the power to operate the unit or turns off the power to the unit. The appearance of the display will show that power is on; absence of the display indicates that either power is off, batteries are discharged, or there is some malfunction. Note that when power is turned off, it may take several seconds to discharge circuit capacity to completely blank the display. The black markings seen have no effect and disappear when power is turned back on.

## 3.2 General Theory Of Operation

**Measurement Principle**

A 4-terminal measurement method is used to determine the resistance of the item under test. This method allows the accurate measurement of low values of resistance in spite of the other resistances present in the connection leads. A known current is supplied to the item under test via two wire leads connected to the +I and -I binding posts on the R1L-BR1 Microohm/Bond Meter front panel. Two other wire leads connected to the +E and -E binding posts on the R1L-BR1 front panel sense the voltage developed across the resistance under test due to the supplied known current. The R1L-BR1 then calculates the resistance of the item under test utilizing Ohm's law, and displays it on a 3 ½ digit display.

**Kelvin Clip Cable Description**

A Kelvin clip consists of two opposing jaws of an alligator style clip which are insulated from each other, so one jaw may be used to connect a source of current to the resistance under test, and the other jaw used to measure the voltage at the test point. The two jaws are spring loaded to clamp onto a cylinder of ½ inch diameter or less.

**WARNING**

**OPERATING THE R1L-BR1 MICROOHM/BOND METER AND TAKING RESISTANCE MEASUREMENTS ON A POWERED OR ENERGIZED COMPONENT COULD CAUSE SERIOUS HARM TO THE OPERATOR AND/OR DAMAGE THE R1L-BR1. BE SURE THE ITEM TO BE MEASURED IS DISCONNECTED FROM OTHER COMPONENTS AND APPARATUS.**

If the battery cells have not been installed, refer to section 2.2. Battery only operation will result in the most stable and accurate readings. The R1L-BR1 may be operated while charging the batteries, however it will not conform to specifications in this configuration.

NOTE: The amount of current available for charging the battery decreases as lower resistance ranges are selected. In the 2 mΩ range, the current supplied to the resistance under test exceeds the charging current, and the battery will be drained.

To obtain the best accuracy, allow the R1L-BR1 to warm up for 15 minutes on the 20 Ω range before making measurements. Even if in battery operation, this will not cause appreciable battery discharge.

**Using the Kelvin Clip cables**

Plug one Kelvin Clip cable dual banana plug across the +E and +I binding posts, and plug the other Kelvin Clip cable dual banana plug across the -E and -I binding posts. Note that in both cases, the small "I" marked on the dual banana plug should go into the respective I binding post.

If Kelvin Clip cables are not used, a pair of shielded cables may be utilized. As occurs in the Kelvin Clip cables in the above paragraph, one cable should have its shield connected to the "+I" binding post and its center conductor connected to the +E binding post. Similarly, the other cable should have its shield connected to the -I binding post and its center conductor to the -E binding post. It is also recommended that the resistance of the cables should not exceed 350 mΩ/conductor.

NOTE: Particularly in the 2 mΩ range, where a test current of approximately 1.4 A is used, excessive lead resistance will prevent an accurate measurement.

Set the Range Switch to the desired measurement range and read the resistance on the liquid crystal display. If the resistance is higher than the selected range, the display will show a "1" and three blank digits, indicating over-range. The decimal point will also appear in the proper location for the selected range.

After prolonged operation on battery power, when the battery voltage approaches the end of its useful range, the "LO BAT" indicator will be seen on the display. Although the battery cells are not fully discharged and they will not be damaged by additional use, this is a warning to the operator that the battery cells need to be charged.

Use of HTP-100 probes with R1L-BR1

1. Connect the BLUE spade lug from the LEFT HTP-100 Probe to the RED E+ terminal of the R1L-BR1.
2. Connect the RED spade lug from the LEFT HTP-100 Probe to the RED I+ terminal of the R1L-BR1.
3. Connect the WHITE spade lug from the RIGHT HTP-100 Probe to the BLACK E- terminal of the R1L-BR1.
4. Connect the BLACK spade lug from the RIGHT HTP-100 Probe to the Black I- terminal of the R1L-BR1.
5. Hold the RED HTP-100 Probe in your left hand and the WHITE HTP-100 Probe in your right hand, and push the probe points against the surface to be measured with sufficient force to cause the points to retract slightly.

# SECTION 4

# PRINCIPLES OF OPERATION

## Power Supply

The internal switching power supply U8 accepts nominal line voltages between 90 and 250 VAC 50/60 Hz, allowing operation worldwide. C1, C2, U1, R1, R2 and R101 form a constant current regulator set to approximately 758 mA for charging the battery. D5 is used to isolate the AC power for the battery. D7 serves to clamp the voltage to less than 5 V when the battery is disconnected. The negative 3.6 volt power supply for U2 and U10 is developed by U5.

## Test Current Path

The test current used to perform the resistance measurement originates from the battery + terminal connected to the +3.6 V power symbol at the emitter of Q1. It flows through Q1 into the COM1 terminal of SW1 and out of the terminal selected by the switch for the measurement range chosen. Each pole of the COM1 section of SW1 is connected to a different tap on the current sensing resistor string made up of R13, R48, R50, R52 and R54. The test current flows into the sense resistor string at the tap selected, out of R54 into D3 and out of D3 to the I+ test jack. The external test leads conduct the current through the resistance being measured and back to the I- test jack, where it returns to ground and then to the battery - terminal.

## Test Current Regulator

The test current is controlled to a constant value for each range with a feedback loop. The main loop amplifier is U9A. The output of U9A controls the conduction of Q1 using Q2, such that if the output voltage of U9A increases, the test current increases. The inputs of U9A compare the voltage across the current sensing resistor string with a 3 volt reference voltage produced by U4, the voltmeter IC. The voltage across the sensing resistor string is maintained at 1.5 V, half the value of the reference voltage because R9 and

R11 are twice the value of R8 and R9. The reference voltage of 3 V is present between the VREF signal at one end of R9 and the +3.6 V power supply present at one end of R11. The voltage at one end of the sensing resistor string is present at U11A pin 1 which feeds R8. The voltage at the other end of the sensing resistor string is present at U11B pin 7 which feeds R10. U11A and U11B are very high input impedance buffer amplifiers which sense the voltage across the current carrying portion of the sensing resistor string without causing errors in the test current. R127, R129 and CR1 provide overvoltage input protection for pin 3 of U11A, and similarly R46, R128 and CR2 for U11B. U2B will shut off the current source if the voltage on the I+ binding post becomes less than about -3 V.

### Test Current Adjustment

The test current on the 2 milliohm range is 1.4 amps. It is very stable, but not adjustable. The 1.4 A current stability is determined by the stability of R54, the 3 V reference developed by U4 and to a minor extent other circuit components. The test currents on the four other ranges are adjusted to approximately 1/10, 1/100, 1/1000 and 1/10000 of the actual value of the 2 milliohm range test current during the calibration/ adjustment process. Trimpots R53, R51, R49 and R114 are used for this adjustment, and are adjusted sequentially in that order. Adjusting the current affects the readings, so current adjustment INDEPENDENT of the readings adjustment is not possible.

### Voltage Measurement

The voltage across the resistance being measured is amplified by U10A, U10B and U9B. The E+ and E- test jacks are the input to this differential amplifier, and the output is connected to the voltmeter IC U4 pins 38 and 39. R130, R131, R141, R142, CR3 and CR4 provide overvoltage input protection. U10A, U10B, R132, R133 and R134 provide a differential gain of 5: the voltage between U10A pin 1 and U10B pin 7 is 5 times the voltage between E- and E+. U9B provides voltage gain of 10, and develops its output between VREF at pin 40 of U4 and VIN+ at pin 39 of U4. An

adjustable bipolar offset voltage is added to this output by R143 before it is applied to VIN- at pin 38 of U4. C18 and 140 are a low pass filter to reduce noise.

The voltmeter IC U4 converts the amplified voltage across the resistance being measured into a displayed reading. Because the test current is precisely regulated along with the various gains chosen in the circuit, the displayed value is directly proportional to the resistance being measured. U4 develops a reference voltage of 3 V between pins 8 and 40. The reference is divided by the resistor string R31, R32, R146 and R143. R146 provides an adjustable voltage used as the analog to digital conversion reference to pin 44. R143 provides an adjustable zero reading.

Display

U4 directly drives the LCD, except for the decimal points and the LOBAT indicator. The decimal point associated with the range selected is displayed when the range switch SW1 provides a +3.6 V signal to one of the inputs of U7. The LOBAT signal is displayed when U2A detects the voltage at pin 40 of U4 falls below ground. Since this pin is maintained by U4 at the reference voltage of 3 V below the battery voltage, LOBAT will be displayed when the battery is less than approximately 3 V.

# SECTION 5

# MAINTENANCE

## 5.1 Inspection

These units should be inspected semi-annually. Cables should be periodically inspected to make sure they are in good condition. Check that the switches turn smoothly. Check all four binding posts to ensure that they operate smoothly.
No other maintenance is required, other than to keep the battery charged through power line operation. Charging should be done for at least 14 hours after long periods (several months) of storage or after considerable use on battery power.

## 5.2 Cleaning

The instrument should be cleaned periodically, as is necessary, using mild soap and a damp cloth, followed by a second damp rinsing cloth.
Clean the LCD window using a soft cloth moistened with water or "Windex" type window cleaner. **DO NOT** use common paper towel products as some brands may contain fibers which could scratch the display window. **DO NOT** apply significant pressure to the LCD window as it could separate from the front panel. **DO NOT** use alcohol, solvents, or harsh chemicals to clean the LCD window.

## 5.3 Test Equipment and Tools Required for Calibration and Repair

Calibration of the R1L-BR1 is recommended on a yearly basis, and is done at a temperature of 23 °C ± 1 °C. To obtain best results, keep the unit at 23 °C ± 1 °C for at least 8 hours, and allow it to warm up for 30 minutes before making any adjustments.

(The calibration procedure and schematics provided in this manual are for the surface mount units manufactured after November 2013. Please contact TEGAM if your instrument is purchased prior to that date.)

Precision four terminal resistors with accuracy of 0.05% or better: 1 mΩ, 1.9 mΩ, 19 mΩ, 190 mΩ, 1.9 Ω, and 19 Ω

A standard 4 ½ digit digital voltmeter: with 2 V range, accuracy better than 0.03% of reading ±1 count.

Screwdrivers: Medium Phillips and small slotted for trim-pot adjustment.

Three 20 AWG approximately 4 inch long Bus Wires

Four 18 AWG Wires (or dual wire cable) approximately 2 feet long with clips

## 5.4 Calibration

**CAUTION**

**SAFETY PRECAUTIONS MUST BE TAKEN WHEN HANDLING THIS INSTRUMENT WHEN THE LINE CORD IS PLUGGED IN AND THE R1L-BR1 HAS BEEN REMOVED FROM ITS CASE, TO ENSURE THAT CONTACT IS NOT MADE WITH THE AC POWER CONNECTIONS OR OTHER POTENTIALLY HARMFUL POINTS. FAILURE TO OBSERVE PROPER SAFETY PRECAUTIONS MAY CAUSE SERIOUS HARM TO THE OPERATOR AND/OR DAMAGE THE R1L-BR1.**

### A. Preparation

1. Remove the front panel assembly from the case by removing the ten retaining screws. Retain the ten screws for reinstallation.
2. Install a new set of approved batteries into the UUT as required. Observe polarity.
3. Plug UUT in and turn on setting the range switch to 20Ω range, allow a 14-hour charge time. (Skip this step if batteries have already been charged.)
4. After the UUT has been charged, unplug the UUT.
5. Allow a 10-minute COOL DOWN.

**NOTE:** Heat from the charging circuit causes the UUT to drift. The COOL DOWN period is only necessary if the UUT has been charging for an extended period of time.

6. Turn the voltmeter on allowing a 10-minute warm up.
   a) Set unit to measure DC voltage.
   b) Set unit to Auto range.
7. Connect clip leads to the voltmeter.

## B. AC Circuitry Check

1. Set the range switch to 20 Ω on the UUT.
2. Connect the voltmeter to the UUT;
   a) Voltmeter Red test lead to TP1 of the UUT,
   b) Voltmeter Black test lead to TP2 of the UUT.
3. Plug the UUT into AC and turn on.
4. Verify the reading on the voltmeter reads between 1.0-1.5VDC.
5. Disconnect the UUT from the AC source.
6. Disconnect the Voltmeter from the UUT.

**NOTE:** The UUT is to be unplugged from AC during the remaining portions of the procedure.

## C. Zero the Display

1. Set the range switch to 2 mΩ on the UUT.
2. Short out all four terminals of the UUT in the following order, +I to –I, –I to +E, +E to –E using the three pieces of buss wire.
3. Adjust R143 for a zero reading ±1 count on the least significant digit as displayed by the UUT.
4. Set the range switch to the next higher range.
5. Verify a zero reading within ±1 count on the least significant digit.
6. Repeat steps 4 and 5 for all remaining ranges.
7. Disconnect the buss wires from the UUT.

## D. 2 mΩ Adjust (Main Gain Adjust)

1. Set the range switch to 2 mΩ on the UUT.
2. Connect a 1.9 mΩ standard to the UUT using the clip leads.

3. Adjust R32 for a display reading of the actual standards value ±3 counts (±0.003 mΩ) on the display of the UUT, typically 1.900. Allow adequate time for any thermals to dissipate and the unit to settle.
4. Repeat sections C-D until both values are with-in specifications.
5. Disconnect the resistance standard.
6. Connect a 1 mΩ standard to the UUT using the clip leads.
7. Verify that the display of the UUT displays the actual standard value ±2 counts.
8. Disconnect the resistance standard.

**NOTE:** The following adjustment steps build upon each other, and must be performed in sequence. It appears that the connection of standards will be more convenient if the steps are performed in reverse order, from H to E, but this will not provide a satisfactory adjustment, as (for example) the Step E adjustment changes the Step H reading.

### E. 20 mΩ Adjust

1. Set the range switch to 20 mΩ on the UUT.
2. Connect a 19 mΩ standard to the UUT using the clip leads.
3. Adjust R53 for a display reading of the actual standards value ±3 counts (±0.03 mΩ) on the display of the UUT, typically 19.00. Allow adequate time for any thermals to dissipate and the unit to quit drifting.
4. Disconnect the resistance standard.
5. Connect a 1.9 mΩ standard to the UUT using the clip leads.
6. Verify that the display of the UUT displays the actual standard value ±2 counts.
7. Disconnect the resistance standard.

### F. 200 mΩ Adjust

1. Set the range switch to 200 mΩ on the UUT.
2. Connect a 190 mΩ standard to the UUT using the clip leads.

3. Adjust R51 for a display reading of the actual standards value ±3 counts (±0.3 mΩ) on the display of the UUT, typically 190.0. Allow adequate time for any thermals to dissipate and the unit to quit drifting.
4. Disconnect the resistance standard.
5. Connect a 19 mΩ standard to the UUT using the clip leads.
6. Verify that the display of the UUT displays the actual standard value ±2 counts.
7. Disconnect the resistance standard.

## G. 2 Ω Adjust

1. Set the range switch to 2 Ω on the UUT.
2. Connect a 1.9 Ω standard to the UUT using the clip leads.
3. Adjust R49 for a display reading of the actual standards value ±3 counts (±0.003 Ω) on the display of the UUT, typically 1.900. Allow adequate time for any thermals to dissipate and the unit to quit drifting.
4. Disconnect the resistance standard.
5. Connect a 190 mΩ standard to the UUT using the clip leads.
6. Verify that the display of the UUT displays the actual standard value ±2 counts.
7. Disconnect the resistance standard.

## H. 20 Ω Adjust

1. Set the range switch to 20 Ω on the UUT.
2. Connect a 19 Ω standard to the UUT using the clip leads.
3. Adjust R114 for a display reading of the actual standards value ±3 counts (±0.03 Ω) on the display of the UUT, typically 19.00. Allow adequate time for any thermals to dissipate and the unit to quit drifting.
4. Disconnect the resistance standard.
5. Connect a 1.9 Ω standard to the UUT using the clip leads.
6. Verify that the display of the UUT displays the actual standard value ±2 counts.
7. Disconnect the resistance standard.

## 5.5 Troubleshooting

Following are possible symptoms, diagnosis, and repair suggestions for use in trouble-shooting (the most likely causes are listed first).

| Symptom | Faulty Component | Repair |
|---|---|---|
| No Display | Batteries | Check for batteries installed & polarity. |
| | Power cord | Check the power cord is plugged in. |
| | Power switch | Check the power switch is ON. |
| | U6 | Check for a square wave between pin 4 & 40 of U4, if present, replace U6. |
| Battery won't charge | Connections | Remove battery cells and bend contact arms inward to ensure better contact with the battery cells.<br>Clean connections if required. |
| | Batteries | Try a new set of batteries. |
| | Fuse | Check fuses. |
| | Fuse (F1) | Check for 12 VDC across C1. If not check for mains on pins 1 & 2 of U8. If not replace U8. If ok, check for aprox. 6 VDC (ref. to common) at the output of U1. If not, replace U1. |
| | U1 | |
| | R1/R101 | If above ok, check for approximately 4.5 VDC (ref. to common) at the anode of D5, if not, replace R1/R101. |
| | D5 | If above ok, check for approximately 3.6 VDC (ref. to common) at the cathode of D5, if not, replace D5. |
| Display reads zero with cables connected to a good resistor | Current o/p | Check for proper current o/p between +I and -I. |
| | Kelvin Clip | If above ok, check the Kelvin cable for continuity from each side to the banana plug. |
| | U9/U11/Q1 | If no current, troubleshoot the const. current circuit and replace U11 or other component(s) if defective. |
| | U10/U9 | If the current and cables are both ok, check the voltage amplifier and replace U10,U9 or other component(s) if defective. |

Table 2: Fault Symptoms and Repair Actions

After trouble-shooting and repair, the instrument must be recalibrated in accordance with 5.4 above.

*Disassembly*

- First remove the line cord and any other connecting wires. Then remove the ten screws of the top (display) panel. Carefully lift the unit out of its cabinet. Remove the three battery cells.
- Remove the four screws that secure the battery plate.
- Loosen the set screws in the knobs for the Power and Range switches, and remove these knobs.
- To separate the printed circuit board from the front panel, remove the two screws and two standoffs appearing in a rectangular pattern around the LCD and control switches. Remove the four nuts from the binding post connections.

*Re-assembly*

To reassemble the unit, repeat the above steps in reverse order, taking care to install the lockwashers on the proper screws.

## 5.6 Preparation for Shipment

The original shipping carton is not reusable.

Remove the battery cells prior to shipment (or inactive storage of 30 days or more) and package them separately. Disassemble the R1L-BR1 as per section 5.5, and extract the negative end of the battery cells first.

Packaging must provide sufficient resilient material, in accordance with standard packaging practices, to prevent excessive shock to the power supply and display during shipment.

## 5.7 Overhaul Instructions

The R1L-BR1 is an all solid-state unit and requires no periodic overhaul, other than routine cleaning, inspection of cables per section 5, and calibration per section 5.4.

However, some disassembly is required to remove and install the batteries. This level of disassembly is detailed in section 2.2 and battery cells should be removed at the negative end first.

Tools and test equipment used for disassembly, calibration, and troubleshooting of the R1L-BR1 are listed in section 5.3.

Troubleshooting suggestions are given in section 5.5.

The only component expected to require replacement is the battery. The battery designation is listed on the Replacement Parts List, with battery cell removal and installation instructions given in section 2.2.

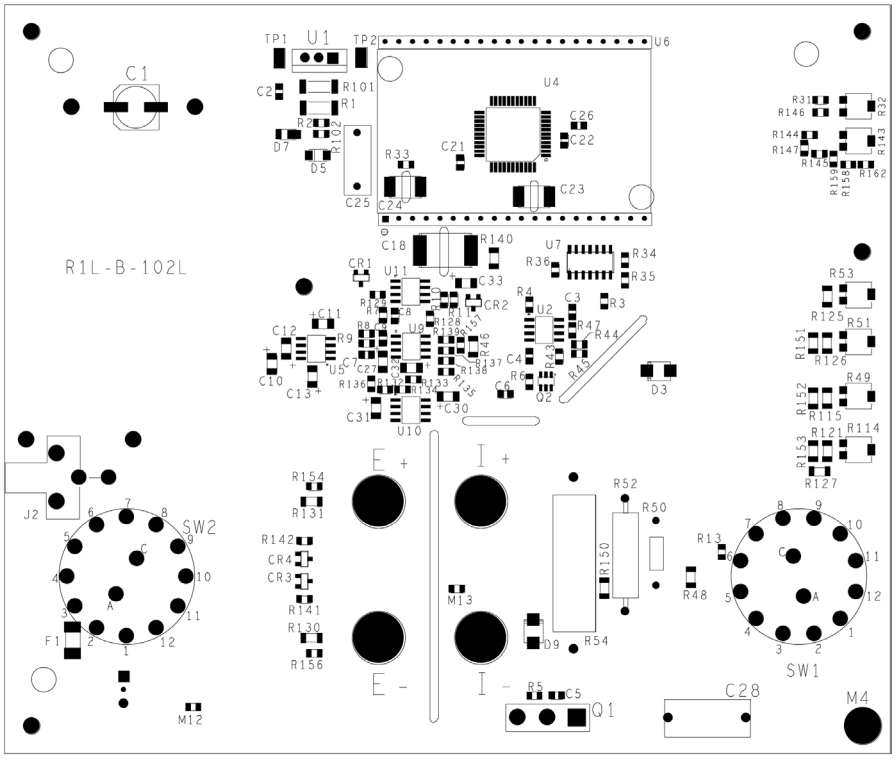


Figure 2: Parts Layout

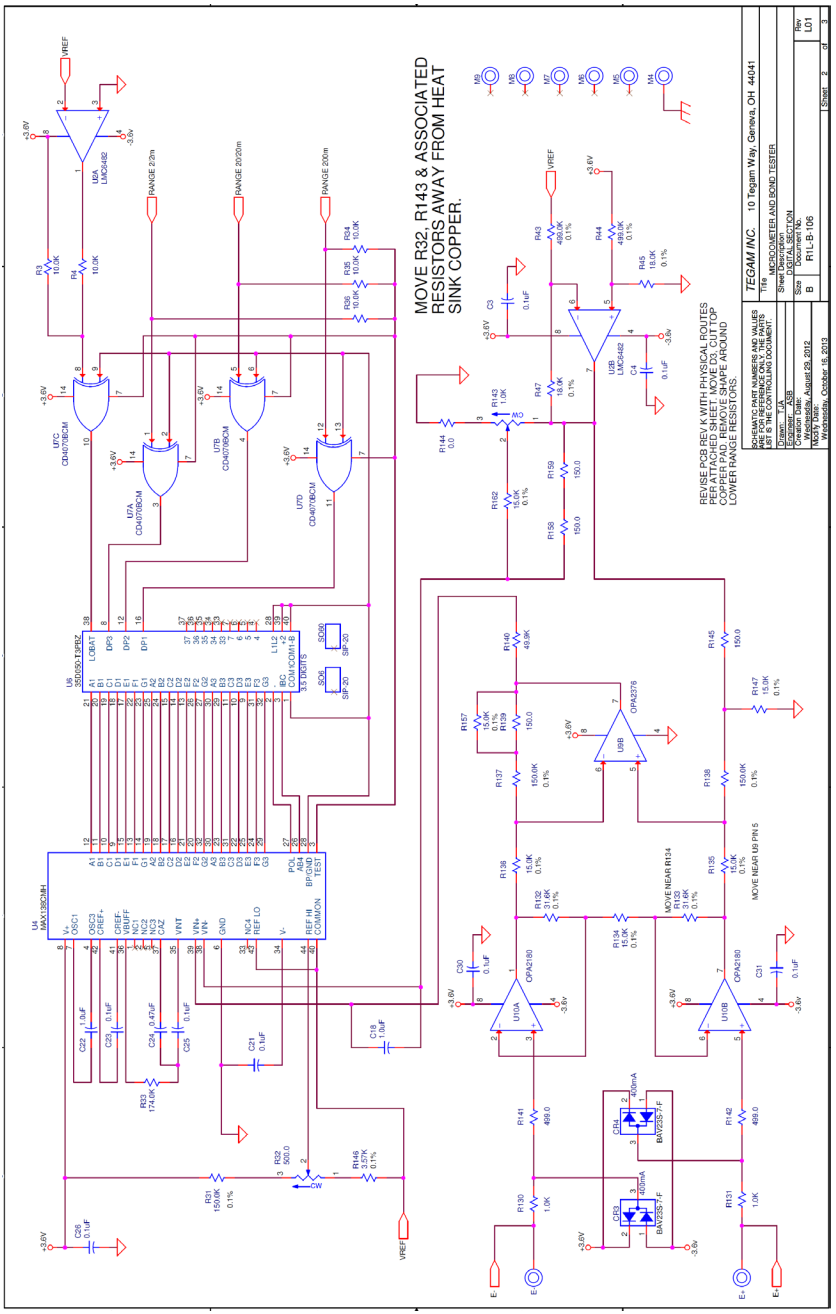
MOVE R32, R143 & ASSOCIATED RESISTORS AWAY FROM HEAT SINK COPPER.
REVISE PCB REV K WITH PHYSICAL ROUTES PER ATTACHED SHEET. MOVE D3, CUT TOP CONNECTION TO R143 AND RE-ROUTE AROUND LOWER RANGE RESISTORS
TEGAM INC. 10 Tegam Way, Geneva, OH 44041
Title: MICROMETER AND BOND TESTER
Sheet Description: DIGITAL SECTION
Size: B
Document No.: R1L-B-106
Rev: L01
Sheet 2 of 3
SCHEMATIC PART NUMBERS AND VALUES ARE FOR REFERENCE ONLY. THE LAST IS THE CONTROLLING DOCUMENT.
Drawn: DAB
Creation Date: Monday, August 29, 2012
Modify Date: Wednesday, October 16, 2013
VREF
RANGE 2/3m
RANGE 20/30m
RANGE 200m
MOVE NEAR R134
MOVE NEAR U9 PIN 5

Figure 3: Digital Section

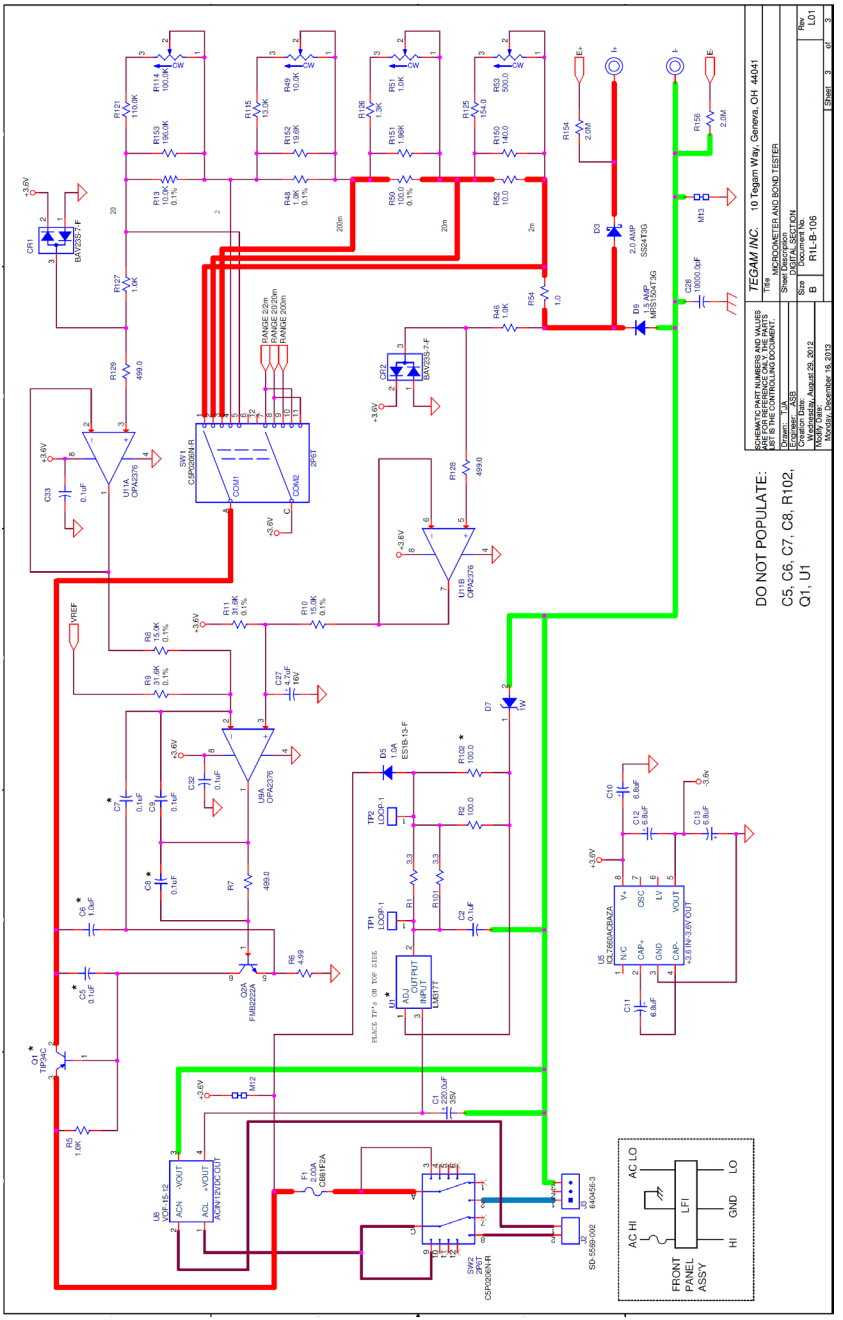


Figure 4: Digital Section

Part Number: R1L-B-100

| Item | Qty | Part Reference | Value | Description | Manufacturer P/N | Manufacturer | TEGAM P/N |
|---|---|---|---|---|---|---|---|
| 1 | 1 | C1 | 220uF | CAP ALUM 220uF 35V F | EEE-1VA221UP | PANASONIC | C-328-220UF |
| 2 | 6 | C2 C3 C4 C9 C21 C26 | 0.1uF | CAP CER 50V X7R 0805 | C0805C104K5RACTU | KEMET | C-610-0.1UF |
| 3 | 4 | C10 C11 C12 C13 | 6.8uF | CAP TANT 16V 10% EIAA | TR3A685K016C3000 | VISHAY | C-606-6.8UF |
| 4 | 1 | C18 | 1.0uF | CAP FILM(PEN) 1.0uF 100V | ECWU1105KCV | PANASONIC | C-335-1.0UF |
| 5 | 1 | C22 | 1.0uF | CAP CER 50V X7R 0805 | GRM21BR71H105KA12L | MURATA | C-0805K-1.0UF |
| 6 | 1 | C23 | 0.1uF | CAP FILM(PEN) 0.1uF 100V 2416 | ECWU1104JC9 | PANASONIC | C-630-0.1UF |
| 7 | 1 | C24 | 0.47uF | CAP FILM(PEN) 0.47uF 16V 2416 | ECWU1C474JC9 | PANASONIC | C-632-0.47uF |
| 8 | 1 | C25 | 0.1uF | CAP FILM(PP) 0.1uF 250V RAD_10MM | ECWF2104JAQ | PANASONIC | C-514-0.1UF |
| 9 | 1 | C27 | 4.7uF | CAP TANT 16V EIAA | TR3A475K016C1500 | VISHAY | C-606-4.7UF |
| 10 | 1 | C28 | 10000pF | CAP CER 250VAC RAD_7.5MM | DE2F3KH103MA3B | MURATA | C-595-10000PF |
| 11 | 4 | C30 C31 C32 C33 | 0.1uF | CAP CER 0.1UF 50V X7R 1206 | C1206C104K5RAC | KEMET | 150036 |
| 12 | 4 | CR1 CR2 CR3 CR4 | BAV23S | DIO FAST DUAL 200V 400mA SOT-23-3 | BAV23S-7-F | DIODES INCORPORATED | DZ-228 |
| 13 | 1 | D3 | SS24 | DIO SCHOTTKY 40V 2A SMB | SS24T3G | ON SEMICONDUCTOR | DZ-157 |
| 14 | 1 | D5 | ES1B | DIO FAST 100V 1A SMA | ES1B-13-F | DIODES INCORPORATED | DZ-172 |
| 15 | 1 | D7 | 5.6V | DIO ZENER 5.6V 1W POWERDI123 | DFLZ5V6 | DIODES INCORPORATED | DZ-180 |
| 16 | 1 | D9 | 1.5 AMP | DIO GP 400V 1.5A SMB | MRS1504T3G | ON SEMICONDUCTOR | DZ-130 |
| 17 | 1 | U6 | | LCD DISP 3.5 DIG 0.5"H IC | 35D050-T3PBZ | FEMA ELECTRONICS CORP | DD-130 |
| 18 | 1 | F1 | 2A | FUSE 2A 125VAC/DC 2410 | CB61F2A | COOPER BUSSMANN | FU-25 |
| 19 | 1 | J2 | 39-29-102 | CONN HEADER RIGHT ANGLE 2X1 4.2MM | 39-29-102 | MOLEX | CS-22 |
| 20 | 1 | J3 | 640456-3 | CONN HEADER VERTICAL 1x3 2.54MM | 640456-3 | TE CONNECTIVITY | CS-199 |
| 22 | 1 | Q2 | FMB2222A | XSISTOR BJT NPN DUAL 40V 500mA TSOT-23-6 | FMB2222A | FAIRCHILD SEMICONDUCTOR | TG-270 |
| 23 | 2 | R1 R101 | 3.3 | RES CARBON FILM 5% 1W MELF 0207 | CMB02070X3308JB200 | VISHAY-BEYSCHLAG | R-250-3.3 |
| 24 | 1 | R2 | 100 | RES THICK FILM 1% 1/8W 0805 | ERJ-6ENF1000V RC0805FR-07100RL | PANASONIC YAGEO | R-618-100 |
| 25 | 5 | R3 R4 R34 R35 R36 | 10.0K | RES THICK FILM 1% 1/8W 0805 | ERJ-6ENF1002V RC0805FR-0710KL | PANASONIC YAGEO | R-618-10K |
| 26 | 1 | R5 | 1.00K | RES THICK FILM 1% 1/8W 0805 | ERJ-6ENF1001V RC0805FR-071KL | PANASONIC YAGEO | R-618-1K |
| 27 | 1 | R6 | 4.99 | RES THICK FILM 1% 1/8W 0805 | RC0805FR-074R99L | YAGEO | R-618-4.99 |
| 28 | 5 | R7 R128 R129 R141 R142 | 499 | RES THICK FILM 1% 1/8W 0805 | ERJ-6ENF4990V | PANASONIC | R-618-499 |

| Item | Qty | Part Reference | Value | Description | Manufacturer P/N | Manufacturer | TEGAM P/N |
|---|---|---|---|---|---|---|---|
| 29 | 8 | R8 R10 R134 R135 R136 R147 R157 R162 | 15.0K | RES THICK FILM 0.1% 1/8W 0805 | ERA-6AEB153V | PANASONIC | R-638-15K |
| 30 | 4 | R9 R11 R132 R133 | 31.6K | RES THICK FILM 0.1% 1/8W 0805 | ERA-6AEB3162V | PANASONIC | R-638-31.6K |
| 31 | 1 | R13 | 10.0K | RES THICK FILM 0.1% 1/8W 0805 | ERA-6AEB103V PFC-W0805LF-03-1002-B-1739 | PANASONIC TT ELEC./IRC | R-638-10K |
| 32 | 3 | R31 R137 R138 | 150K | RES THICK FILM 0.1% 1/8W 0805 | ERA-6AEB154V | PANASONIC | R-638-150K |
| 33 | 2 | R32 R53 | 500 | RES TRIMMER 1/4W 12-TURN 4mm SQ SMD | 3224G-1-501E | BOURNS | RP-103-500 |
| 34 | 1 | R33 | 174K | RES THICK FILM 1% 1/8W 0805 | ERJ-6ENF1743V RC0805FR-07174KL | PANASONIC YAGEO | R-618-174K |
| 35 | 2 | R43 R44 | 499K | RES THICK FILM 0.1% 1/8W 0805 | ERA-6AEB4993V | PANASONIC | R-638-499K |
| 36 | 2 | R45 R47 | 18.0K | RES THICK FILM 0.1% 1/8W 0805 | ERA-6AEB183V | PANASONIC | R-638-18K |
| 37 | 4 | R46 R127 R130 R131 | 1.00K | RES THICK FILM 1% 1/4W 1206 | ERJ-8ENF1001V | PANASONIC | R-515-1K |
| 38 | 1 | R48 | 1.00K | RES THICK FILM 0.1% 1/4W 1206 | RG3216P-1001-B-T1 | SUSUMU | R-550-1.0K |
| 39 | 1 | R49 | 10K | RES TRIMMER 1/4W 12-TURN 4mm SQ SMD | 3224G-1-103E | BOURNS | RP-103-10.0K |
| 40 | 1 | R50 | 100 | RES METAL FILM 0.1% 1/2W AX | CMF55100R00BEEB | VISHAY | R-169-100 |
| 41 | 2 | R51 R143 | 1K | RES TRIMMER 1/4W 12-TURN 4mm SQ SMD | 3224G-1-102E | BOURNS | RP-103-1.0K |
| 42 | 1 | R52 | 10.0 | RES WW 1% 3W AX | 43F10RE | OHMITE | R-275-10 |
| 43 | 1 | R54 | 1.00 | RES WW 1% 5W AX | 45F1R0E | OHMITE | R-341-1 |
| 44 | 1 | R114 | 100K | RES TRIMMER 1/4W 12-TURN 4mm SQ SMD | 3224G-1-104E | BOURNS | RP-103-100.0K |
| 45 | 1 | R115 | 13.0K | RES THICK FILM 1% 1/4W 1206 | ERJ-8ENF1302V | PANASONIC | R-515-13K |
| 46 | 1 | R121 | 110K | RES THICK FILM 1% 1/4W 1206 | ERJ-8ENF1103V | PANASONIC | R-515-110K |
| 47 | 1 | R125 | 154 | RES THICK FILM 1% 1/4W 1206 | ERJ-8ENF1540V | PANASONIC | R-515-154 |
| 48 | 1 | R126 | 1.30K | RES THICK FILM 1% 1/4W 1206 | ERJ-8ENF1301V | PANASONIC | R-515-1.3K |
| 49 | 4 | R139 R145 R158 R159 | 150 | RES THICK FILM 0.1% 1/8W 0805 | ERA-6AEB151V | PANASONIC | R-638-150 |
| 50 | 1 | R140 | 49.9K | RES THICK FILM 1% 1/4W 1206 | ERJ-8ENF4992V | PANASONIC | R-515-49.9K |
| 51 | 1 | R144 | 0.0 | RES THICK FILM JUMPER 1/8W 0805 | ERJ-6GEY0R00V RC0805JR-070RL | PANASONIC YAGEO | R-618-0 |
| 52 | 1 | R146 | 3.57K | RES THICK FILM 0.1% 1/8W 0805 | ERA-6AEB3571V RG2012P-3571-B-T5 | PANASONIC SUSUMU | R-638-3.57K |
| 53 | 1 | R150 | 140 | RES THICK FILM 1% 1/4W 1206 | ERJ-8ENF1400V | PANASONIC | R-515-140 |
| 54 | 1 | R151 | 1.96K | RES THICK FILM 1% 1/4W 1206 | ERJ-8ENF1961V | PANASONIC | R-515-1.96K |
| 55 | 1 | R152 | 19.6K | RES THICK FILM 1% 1/4W 1206 | ERJ-8ENF1962V | PANASONIC | R-515-19.6K |
| 56 | 1 | R153 | 196K | RES THICK FILM 1% 1/4W 1206 | ERJ-8ENF1963V | PANASONIC | R-515-196K |

| Item | Qty | Part Reference | Value | Description | Manufacturer P/N | Manufacturer | TEGAM P/N |
|---|---|---|---|---|---|---|---|
| 57 | 2 | R154, R156 | 2.0M | RES THICK FILM 1% 1/8W 0805 | ERJ-6ENF2004V | PANASONIC | R-618-2.0M |
| 58 | 2 | SO6 SO60 | SIP-20 | CONN SIL-SOCKET 0.472" STANDOFF HEIGHT 20-POS | 316-93-120-41-008000 | MILL-MAX | SO-314-20 |
| 59 | 2 | SW1 SW2 | 2P6T | SW ROTARY DP 6-POS | C5P0206N-R | ELECTROSWITCH | SW-419 |
| 60 | 2 | TP1 TP2 | S1751-46R | TP LOOP SMD | S1751-46R | HARWIN INC. | CS-122 |
| 61 | 1 | U10 | OPA2180 | IC OPAMP DUAL ZERO-DRIFT SOIC-8 | OPA2180IDR | TEXAS INSTRUMENTS | IC-352 |
| 62 | 2 | U11 U9 | OPA2376 | IC OPAMP DUAL LOW NOISE SOIC-8 | OPA2376AID | TEXAS INSTRUMENTS | IC-358 |
| 63 | 1 | U2 | LMC6482 | IC OPAMP DUAL CMOS SOIC-8 | LMC6482IM/NOPB | TEXAS INSTRUMENTS | IC-251 |
| 64 | 1 | U4 | MAX138 | IC 3.5 DIGIT ADC W/LCD DRIVER QFP-44 | MAX138CMH | MAXIM | IC-241 |
| 65 | 1 | U5 | 7660 | IC REGULATOR SWITCHED CAP SOIC-8 | ICL7660ACBAZA | INTERSIL | IC-809 |
| 66 | 1 | U6 | 3.5DIGIT LCD | DISPLAY 3.5 DIGIT W/ ±AND LOBAT IND., USE W/ BACKLIGHT | 35D050-T3PBZ | FEMA ELEC. | DD-130 |
| 67 | 1 | U7 | 4070B | IC QUAD 2-INPUT XOR SOIC-14 | CD4070BM96 | TEXAS INSTRUMENTS | IC-863 |
| 68 | 1 | U8 | VOF-15-12 | PS 12VDC 1.25A OPEN FRAME PCB MOUNT | VOF-15-12 | CUI INC | PS-128 |

Table 3: Parts List – Main Board Assembly

| Part Number | Part Description | Qty | UM | Manufacturer | Cage Code | Mfg Part |
|---|---|---|---|---|---|---|
| BA-110 | BATT,C,NICAD,3000mAh | 3 | EA | PANASONIC | 0HF77 | P-280CR |
| | | | | SANYO | 00JU0 | N-3000CR |
| | | | | TENERGY | 55R99 | 20400 |
| R1L-BR1-040 | FRONT PANEL ASSY | 1 | EA | TEGAM, INC | 49374 | |
| KAK-1M | CBL, KELVIN-BANANA, R1L-BR1 | 1 | EA | SILVERTRONIC | | 129609 |
| BCP-10 | KELV PRB, SPRING LOAD PINS | 1 | EA | C PETROVIC | | BCP-10 |
| BCP-10-A | PIN SET, 8 PINS, A STYLE | 1 | EA | | | |
| CO-115 | LINECORD | 1 | EA | VOLEX | U7112 | 17250-10-B1 |
| PK-5000 | POCKT POUCH R1L-BR1 | 1 | EA | ELLIS CH | 0TJ49 | PK-5000 |
| R1L-BR1-900-01 | OPERATION MANUAL | 1 | EA | ACTIVITIES PRESS | | R1L-B-900-01 |
| R1L-B/BR-841 | CD MANUAL MILITARY | AR | EA | TEGAM, INC | 49374 | |
| MC-1212 | R1L-BR1 LABEL | 1 | EA | NUTRON NAMEPLATE | 30236 | MC-1212 |
| 1531 | CASE, R1LC-080 | 1 | EA | AMERIPACK | 0TJ49 | 1013 |
| 5879 | TBG, N16 VINYL FBGL, GRN | AR | FT | | | |
| DOC-019 | PRODUCT SPEC SHEET TEMP | REF | EA | | | |

Table 4: Parts List – R1L-BR1 Final Assembly

Part Number: R1L-BR1-040

| Part Number | Part Description | Ref | Qty | UM | Manufacturer | Cage Code | Mfg Part |
|---|---|---|---|---|---|---|---|
| BP-50-0 | BIND POST CON GLD-PLT BLK | BP -I, BP -E | 2 | EA | POMONA ELECTRONICS | 5D6S9 | 3750-0 |
| BP-50-2 | BIND POST CON GLD-PLT RED | BP +I, BP +E | 2 | EA | POMONA ELECTRONICS | 5D6S9 | 3750-2 |
| CS-104 | CON,DUL,BINDPOST,BASE BLK | BP +I, +E,-I,-E | 2 | EA | POMONA ELECTRONICS | 5D6S9 | 3862 |
| PE-2 | PWR ENTRY LINEFILTER 3A | LF1 | 1 | EA | CORCOM | 38AS8 | 3EEA1 |
| | | | | | TYCO\TE CONNECTIVITY | 1Z830 | 6609000-4 |
| FH-20 | FUSE HLD PNL MNT 6.3X32MM | XF1 | 2 | EA | LITTELFUSE | 7E222 | 03453LF1H |
| FU-202 | FUSE,1/4A 3AG SLOW BLOW | F1 | 2 | EA | LITTELFUSE | 7E222 | 313.25 |
| | | | | | LITTELFUSE | 7E222 | 313.250HXP |
| IN-7 | SIL-PAD,HEATPAD TO -220 | | 2 | EA | BERGQUIST | 55285 | 3223-07FR-90 |
| | | | | | BERGQUIST | 55285 | SP400-0.007-00-90 |
| WA-20 | WSH,NYLON #4 | Q1,U1 | 2 | EA | THERMALLOY | 13103 | 7721-7PPS |
| | | | | | THERMALLOY | 13103 | 7721-7PPSG |
| | | | | | TEGAM, INC | 49374 | 210117800 |
| | | | | | ITW PANCON | 0K1B5 | CE100F22-3-D |
| 210108 | LUG,SOLDER,#4 | | 1 | EA | KEYSTONE ELECTRONICS | 91833 | 908 |
| 12373 | DISPLAY GASKET R1L-B | | 2 | EA | GASKO | 6R887 | 12373 |
| ST-318 | STNDOF,8-32X1/2"HEX BRS Z | | 4 | EA | MCMASTER-CARR | 0KVE6 | 92700A452 |
| WA-244 | WSH,#8 LOCK,GLD PLATED | | 4 | EA | MPT FASTENER | 45T10 | BUY WIT NUT-8/32 & WA-242 |
| NUT-8/32GLD | NUT,HEX,8-32,GLD PLATED | | 4 | EA | MPT FASTENER | 45T10 | BUY WITH WA-242 & WA-244 |
| MS51957-13 | SCR PH 4-40 X 1/4 LG | | 6 | EA | MPT FASTENER | 45T10 | NON MIL EQUAL BY DESC |
| 4-40X1/2PFHBLK | SCW,PFH,4/40X1/2,SS,BLK | | 2 | EA | MPT FASTENER | 45T10 | |
| 3538 | NUT,HEX,4-40 | | 6 | EA | BEAVER BOLT | OB6M9 | 3538 |
| | | | | | MPT FASTENER | 45T10 | 4-40 HEX NUT 18-8 |
| MS35338-135 | WSH LOCK #4 | | 11 | EA | MPT FASTENER | 45T10 | NON MIL EQUAL BY DESC |
| 6168 | WIRE,N18 STR GRN TFLN | | AR | FT | BIRNBACH | 71002 | 8518/19 GRN |
| | | | | | BELDEN WIRE AND CABLE | 3HXC8 | 83029 005100 |
| | | | | | TEGAM, INC | 49374 | 079-145-5 |
| | | | | | TEGAM, INC | 49374 | 600005 |
| KN-106 | KNOB,ROUND,KNURLED.6 .4MM | | 2 | EA | MULTICOMP/SPC | 75498 | MC21051 |
| CS-21 | CONN,PUSH ON | | 1 | EA | MOLEX | KB925 | 39012020 |
| CS-105 | CONN,TERM,FEMLE,18-24 AWG | | 2 | EA | MOLEX | KB925 | 39-00-0039 |
| ST-335 | STANDOFF,4-40X3/4 HEX | | 4 | EA | MCMASTER-CARR | 0KVE6 | 91780A745 |

| Part Number | Part Description | Ref | Qty | UM | Manufacturer | Cage Code | Mfg Part |
|---|---|---|---|---|---|---|---|
| 015-317 | IC VOLT REG ADJ | | 1 | EA | FAIRCHILD SEMICONDUCTOR | 4E8P4 | LM317T |
| | | | | | NATIONAL SEMICONDUCTOR | | LM317T |
| TG-34 | XISTOR,BIPOLAR,PNP | | 1 | EA | MOTOROLA | | TIP34 |
| | | | | | ST MICROELECTROINCS | SCE76 | TIP34C |
| | | | | | TEGAM, INC | 49374 | 079-148-8 |
| | | | | | TEGAM, INC | 49374 | 600008 |
| TX-20-3/16 | TUBING SHRINK 3/16 | | AR | EA | ALPHA WIRE & CABLE | 92194 | FIT221 3/16 |
| | | | | | ALLIED WIRE & CABLE | 92194 | HST221-3/16 |
| | | | | | TEGAM, INC | 49374 | 6196 |
| MS35338-137 | WSH LOCK,SPLT,#8 | | 4 | EA | TEGAM, INC | 49374 | 50626 |
| | | | | | TEGAM, INC | 49374 | NAS1676C8 |
| | | | | | MPT FASTENER | 45T10 | NON MIL EQUAL BY DESC |
| R1LBR1-319 | FRONT PANEL | | 1 | EA | AMERICAN METAL SPECIALTIE | 5JH28 | R1LBR1-319 |
| R1LBR1-320 | FRONT PNLW/ OVERLAY | | REF | EA | | | |
| R1LBR1-321 | FRONT PNL OVERLAY R1L-BR1 | | 1 | EA | NUTRON NAMEPLATE | 30236 | PER PRINT |
| R1L-B-100 | PC ASSY, R1L-B | | 1 | EA | TEGAM, INC | 49374 | |
| R1L-BR1-700 | FIXTURE FRNT PNL | | REF | EA | | | |
| DD-130 | LCD DISP 3.5 DIGIT 0.5"H IC | | 1 | EA | FEMA ELECTRONICS CORP | OP7Z6 | 35D050-T3PBZ |
| SW-419 | SWITCH ROTARY 2 POLE 2 POS | | 2 | EA | ELECTROSWITCH<br>TEGAM, INC<br>TEGAM, INC | <br>49374<br>49374 | C5P0206N-4006<br>SW-420<br>SW-421 |
| SO-314-20 | SOCKET ROW 20 PIN SIP | | 2 | EA | MILL-MAX | 3N087 | 316-93-120-41-008-000 |
| 999920-000 | WIR,20 AWG TFE BLACK | | AR | EA | BELDEN WIRE AND CABLE | 3HXC8 | 83007-010 |
| 999920-008 | WIR,20 AWG TFE GREY | | AR | EA | BELDEN WIRE AND CABLE | 3HXC8 | 83007-008 |
| ST-317 | STNDOF,4-40X.25 M/F STEEL | | 4 | EA | MCMASTER-CARR | 0KVE6 | 93620A430 |
| R1L-B-200 | PC ASSY R1L-B BATT BRD | | 1 | EA | TEGAM, INC | 49374 | |
| LOCTITE263 | LOCTITE,263,HI STG,THRD | | AR | EA | LOCTITE | 05972 | 263 |

Table 5: Parts List – R1L-BR1 Front Panel Assembly

Part Number: R1L-B-200

| Part Number | Part Description | Qty | UM | Manufacturer | Cage Code | Mfg Part |
|---|---|---|---|---|---|---|
| R1L-B-172 | PCB BATTERY BRD R1L-B | 1 | EA | ALPHA CIRCUITS | 33TM7 | R1L-B-172 |
| BH-107 | BATT HOLDER END "C" INSUL | 6 | EA | KEYSTONE ELECTRONICS | 91833 | 87 |
| EY-35 | EYELET 3/32X0.156 | 12 | EA | KEYSTONE ELECTRONICS | 91833 | 35 |

| Part Number | Part Description | Qty | UM | Manufacturer | Cage Code | Mfg Part |
|---|---|---|---|---|---|---|
| BH-25 | BATT HOLDER KEY INSUL | 3 | EA | KEYSTONE ELECTRONICS | 91833 | 59 |
| CS-211-3 | CONN,3 PIN,IDC INLINE | 1 | EA | ITW PANCON | 0K1B5 | CE100F22-3-C |
| | | | | ITW PANCON | 0K1B5 | CE100F22-3-D |
| 999924-000 | WIR,24 AWG,TEFLON BLK | AR | IN | BELDEN WIRE AND CABLE | 3HXC8 | 83003-10/BLK |
| 999924-002 | WIR,24 AWG,RED,TEFLON | AR | IN | BELDEN WIRE AND CABLE | 3HXC8 | 83003-2(RED) |
| 999924-003 | WIR,24 AWG,TFE,ORANGE | AR | IN | BELDEN WIRE AND CABLE | 3HXC8 | 83003-3(ORNG) |
| TX-20-3/16 | TUBING SHRINK 3/16 | AR | EA | ALPHA WIRE & CABLE | 92194 | FIT221 3/16 |
| | | | | ALLIED WIRE & CABLE | 92194 | HST221-3/16 |
| | | | | TEGAM, INC | 49374 | 6196 |
| ST-420 | SPA, INS PCB, NYL,.250X.260 | 2 | EA | KEYSTONE ELECTRONICS | 91833 | 9029 |

Table 6: Parts List –Battery Board Assembly

| Manufacturer | Cage Code |
|---|---|
| ABBATRON HH SMITH | 91967 |
| ALPHA | 92194 |
| AMERIPACK | OTJ49 |
| AVX | 16299 |
| BELDEN | 3HXC8 |
| BOURNS | F0978 |
| C&K | 63HW9 |
| COMMERCIAL-SEE MCMASTER CARR | |
| CONCORD | 18310 |
| COOPER BUSSMANN | 1UW16 |
| CORCOM | 38AS8 |
| CUSTOM COIL | 0VYL0 |
| DIALIGHT (DIALCO) | 96312 |
| DISCH-SEE TEGAM | |
| EAGLE | 0MPC5 |
| ELECTROSWITCH | 8T045 |
| ELECTRO-TECH SYSTEMS | 56541 |
| ETCHED METAL-SEE TEGAM | |
| FAIRCHILD SEMICONDUCTOR | 4E8P4 |
| FEMA | OP7Z6 |
| GE (MG CHEMICALS) | L3160 |
| GRAYHILL | 81073 |
| HARWIN INC. | 06EX9 |
| ILLINOIS CAPACITOR | 74840 |
| INTERSIL CORPORATION | K0331 |
| KEMET ELECTRONICS | 31433 |
| KOA | 59124 |
| LITTLEFUSE | 7E222 |

| Manufacturer | Cage Code |
|---|---|
| MAXIM | 1ES66 |
| MCMASTER CARR | OKVE6 |
| MICRO COMMERCIAL | 374W0 |
| MILL MAX | 3N087 |
| MOLEX | KB925 |
| MOTOROLA | 0G546 |
| MPT FASTENER | 45T10 |
| MULTICOMP | 75498 |
| MULTI-CONTACT | 0WCJ0 |
| MURATA ELECTRONICS NA | 3EH09 |
| NATIONAL SEMICONDUCTOR | 0G557 |
| OHMITE | 03615 |
| OLDAKER | 64882 |
| ON SEMICONDUCTOR | 59PE1 |
| PANASONIC | 0HF77 |
| PHILIPS | 0TBA7 |
| POMONA | 5D6S9 |
| PPM-SEE TEGAM | |
| SPRAGUE | 5079 |
| SUSUMU | SAW40 |
| ST MICROELECTRONICS | SCE76 |
| TEGAM, INC | 49374 |
| TEXAS INSTRUMENTS | 8T904 |
| TYCO | Z9V34 |
| TYTON | 3E655 |
| VISHAY | 56845 |
| VOLEX POWER CORDS | U7112 |
| | |

Table 7: Vendor Cage Code Directory

# SECTION 6

# SERVICE INFORMATION

## Preparation for Calibration or Repair Service

Once you have verified that the cause for R1L-BR1 malfunction cannot be solved in the field and the need for repair and calibration service arises, contact TEGAM customer service to obtain an RMA, (Returned Material Authorization), number. You can contact TEGAM customer service via the TEGAM website, www.tegam.com or by calling 440.466.6100 (*All Locations*) OR 800.666.1010 (*United States Only*).

The RMA number is unique to your instrument and will help us identify you instrument and to address the particular service request by you which is assigned to that RMA number.

Of even importance, a detailed written description of the problem should be attached to the instrument. Many times repair turnaround is unnecessarily delayed due to a lack of repair instructions or of a detailed description of the problem.

This description should include information such as measurement range, and other instrument settings, type of components being tested, are the symptoms intermittent?, conditions that may cause the symptoms, has anything changed since the last time the instrument was used?, etc. Any detailed information provided to our technicians will assist them in identifying and correcting the problem in the quickest possible manner. Use a copy of the Repair and Calibration Service form provided on the next page.

Once this information is prepared and sent with the instrument to our service department, we will do our part in making sure that you receive the best possible customer service and turnaround time possible.

# Expedite Repair & Calibration Form

Use this form to provide additional repair information and service instructions. The Completion of this form and including it with your instrument will expedite the processing and repair process.

| | | | |
|---|---|---|---|
| RMA#: | | Instrument Model #: | |
| Serial Number: | | Company: | |
| Technical Contact: | | Phone Number: | |
| Additional Contact Info: | | | |

## Repair Instructions:

☐ Evaluation ☐ Calibration Only ☐ Repair Only
☐ Repair & Calibration ☐ Z540

**Detailed Symptoms:**

Include information such as measurement range, instrument settings, type of components being tested, is the problem intermittent? When is the problem most frequent?, has anything changed with the application since the last time the instrument was used?, etc.

| |
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## Warranty

TEGAM, Inc. warrants this product to be free from defects in material and workmanship for a period of one year from the date of shipment. During this warranty period, if a product proves to be defective, TEGAM Inc., at its option, will either repair the defective product without charge for parts and labor, or exchange any product that proves to be defective.

TEGAM, Inc. warrants the calibration of this product for a period of one year from date of shipment. During this period, TEGAM, Inc. will recalibrate any product, which does not conform to the published accuracy specifications.

In order to exercise this warranty, TEGAM, Inc., must be notified of the defective product before the expiration of the warranty period. The customer shall be responsible for packaging and shipping the product to the designated TEGAM service center with shipping charges prepaid. TEGAM Inc. shall pay for the return of the product to the customer if the shipment is to a location within the country in which the TEGAM service center is located. The customer shall be responsible for paying all shipping, duties, taxes, and additional costs if the product is transported to any other locations. Repaired products are warranted for the remaining balance of the original warranty, or 90 days, whichever period is longer.

## Warranty Limitations

The TEGAM, Inc. warranty does not apply to defects resulting from unauthorized modification or misuse of the product or any part. This warranty does not apply to fuses, batteries, or damage to the instrument caused by battery leakage.
The foregoing warranty of TEGAM is in lieu of all other warranties, expressed or implied. TEGAM specifically disclaims any implied warranties of merchantability or fitness for a particular purpose. In no event will TEGAM be liable for special or consequential damages. Purchaser's sole and exclusive remedy in the event any item fails to comply with the foregoing express warranty of TEGAM shall be to return the item to TEGAM; shipping charges prepaid and at the option of TEGAM obtain a replacement item or a refund of the purchase price.

## Statement of Calibration

This instrument has been inspected and tested in accordance with specifications published by TEGAM Inc. The accuracy and calibration of this instrument are traceable to the National Institute of Standards and Technology through equipment, which is calibrated at planned intervals by comparison to certified standards maintained in the laboratories of TEGAM Inc.

**Contact Information**
TEGAM INC.
10, TEGAM WAY
GENEVA, OHIO 44041
*CAGE Code: 49374*
*WEB:* ***http://www.tegam.com***